Anastomotic Construction

9

Steven R. Hunt and Matthew L. Silviera

Key Concepts
- Benign effluent from a peri-anastomotic drain does not rule out anastomotic leak or abscess.
- It is safe practice to leave the mesenteric defect open after constructing an ileocolic anastomosis.
- Fecal diversion reduces septic complications in patients with coloanal anastomoses.
- Diverting loop ileostomy and loop colostomy have similar complication rates.
- Leak testing should be performed on anastomoses to the rectum.

Introduction

- This chapter will focus on the most common techniques and the problems associated with construction of anastomoses.
- Various clinical situations and differing anatomy make it important to be familiar with multiple approaches to the same type of anastomosis.

S. R. Hunt (✉) · M. L. Silviera
Division of General Surgery, Section of Colon and Rectal Surgery, Department of Surgery, Barnes Jewish Hospital, Washington University School of Medicine, St. Louis, MO, USA
e-mail: hunts@wudosis.wustl.edu

- No matter how well planned the creation of an anastomosis, problems may arise during execution, and the ability to salvage an anastomosis is a skill every colorectal surgeon must master.

General Principles of Anastomoses

Surgical Staplers

- Rudimentary surgical staplers first appeared in the early 1900s. They improved dramatically in the 1970s with preloaded disposable cartridges of multiple staggered staple lines. Titanium staples have replaced stainless steel. A variety of staple heights are available to match tissue thickness.
- The simplest linear stapler (TA or thoracoabdominal) applies two rows of staples in a staggered configuration.
- The linear cutting stapler (GIA or gastrointestinal anastomosis) applies four rows of staggered staples and cuts between the middle two rows of staples.
- Circular staplers (e.g., EEA: end-to-end anastomosis) have a detachable anvil. Once the anvil and head are coupled together, two circular rows of staggered staples are applied as a circular blade cuts out the interior tissue, allowing communication of the two lumens.

Handsewn Anastomoses

- Gastrointestinal anastomoses have been performed by various handsewn techniques.
- No difference in anastomotic leak rates has been shown between single-layer and double-layer anastomoses, interrupted and continuous suture techniques, or type of suture material (absorbable monofilament vs absorbable braided)

Compression Anastomoses

- A compression anastomosis (first reported in the 1800s) is created when two ends of bowel are held together for a period of time by physical forces during which anastomotic healing takes place. The compressed tissue necroses and the device separates and is passed. The anastomosis is held together by the adhesions that form between the tissues adjacent to the area of necrosis.
- In the 1980s the biofragmentable anastomotic ring (BAR) was developed and studied extensively. Despite the encouraging clinical data, several reports of intraoperative problems with the BAR emerged, and the device never gained widespread acceptance.
- A more recent device utilizes a smart metal (Nitinol) that is a temperature-dependent, shape-memory alloy. Two compression rings are mounted on an instrument that is very similar to a conventional EEA stapler (ColonRing).
- There is no prospective randomized data on ColonRing, and it has been taken off the market in the United States.

Tension

- One of the tenants of anastomotic creation is that it must be tension-free. This can be a significant problem with the pelvic colorectal anastomosis.
- In order to gain adequate length of the descending colon so that it may reach down into the pelvis, three maneuvers may be employed: (1) high ligation of the IMA, (2) ligation of the IMV at the inferior border of the pancreas, and (3) complete mobilization of the splenic flexure with division of the distal transverse colon mesentery back to the middle colic vessels.

Blood Supply

- Adequate blood supply to the ends of the bowel is another tenant of anastomoses.
- Visual confirmation of bowel viability is not entirely sufficient.
- Pulsatile, bright red bleeding from the marginal artery at the cut edge of the proximal portion of bowel to be anastomosed confirms excellent perfusion.
- Very dark or even black blood from the marginal artery often indicates a problem with the venous outflow and requires a change in the level of the planned anastomosis.
- Another method of intraoperative perfusion assessment uses near-infrared indocyanine green (ICG)-induced fluorescence angiography.
- A prospective, multicenter, clinical trial studied the utility of fluorescence angiography on colorectal anastomoses with the mean level of anastomosis 10 cm from the anal verge. The overall anastomotic leak rate was 1.4%. In the 8% of patients who had a change in their anastomotic plan due to findings from the perfusion assessment, none of the patients had an anastomotic leak.

Prophylactic Drainage

- The prophylactic use of drains to avoid anastomotic complications is controversial and varies among surgeons.
- Multiple studies have been conducted with varying results.
- Open or passive drains are made of synthetic material and act to provide a route of egress for fluids.
- Closed suction drains consist of a soft, hollow tube that is placed under negative pressure to actively evacuate fluids.

- Advocates of drainage maintain that drains will prevent the accumulation of fluid or blood around the anastomosis, permit early detection of a leak, mitigate the consequences of a leak, and provide a "window into the abdomen."
- Critics assert that drains provide the surgeon with a false sense of security, that they may cause a leak secondary to negative pressure, or that they may provide an avenue for the introduction of infection.
- Meta-analyses of prophylactic drainage includes a heterogenous group of studies with regard to the type of drain used and the location of the anastomoses and do not show a difference in clinical anastomotic leak, radiographic anastomotic leak, wound infection, reoperation, and mortality.
- The largest randomized controlled trail of closed suction drainage had both intraperitoneal and extraperitoneal colonic anastomoses and found no difference between groups.
- A more recent systematic review of observational studies looking strictly at extraperitoneal colorectal anastomoses showed that there was a difference in the rate of anastomotic leakage favoring the drained group.
- While there is scant data to support routine prophylactic drainage, there is no evidence that drains cause adverse events.
- Benign appearing effluent in the drain does not rule out an anastomotic leak or abscess.

Treatment of Mesenteric Defects

- For open colon resections, routine closure of the mesenteric defect was considered essential to avoid internal herniation leading to obstruction or strangulation.
- While the catastrophic consequences of an open mesenteric defect have been discussed in case reports, studies that have looked at this question specifically have shown that it is safe to leave the defect open after creating an ileocolic anastomosis.
- With ileorectal and ileal pouch anal anastomoses, there is the risk of axial torsion of the

small bowel around the free edge of the mesentery. Some surgeons choose to close this defect by securing the free edge of the small bowel mesentery to the preaortic retroperitoneal fascia however there is no evidence to support this practice.

Diversion

- For an in-depth discussion on diversion, see Chap. 55.
- Fecal diversion has a role in protecting distal anastomoses that are at high risk for leakage.
- Any anastomosis within 5 cm of anal verge should be considered for diversion as they have a five- to six-fold increase in the rate of clinical anastomotic leakage compared to more proximal anastomoses.
- Defunctioning stomas can also be used to divert more proximal anastomoses at risk for leakage. Diversion in these settings should be used judiciously, as proximal diversion itself is not a license to create an anastomosis regardless of the clinical situation.
- Diversion mitigates the consequences of anastomotic leaks, but the difficulty lies in predicting which patients are most likely to leak.
- Diverting stomas and the procedure to reverse them have their own attendant morbidity.
- In theory, proximal diversion decreases the load of contamination in an anastomotic leak and may allow the body to seal off a leak – diminishing clinical consequences. Multiple studies demonstrate that diverted anastomoses have a decreased rate of fecal peritonitis, sepsis, and reoperation.
- Both loop colostomies (Fig. 9.1) and loop ileostomies have advantages and disadvantages.
- Ileostomies are associated with peristomal dermatitis, pouching difficulties, dehydration, and acute renal failure.
- Diverting colostomies are more prone to prolapse and are more difficult to close through a peristomal incision and increase the risk of disrupting the marginal blood supply to the colon.
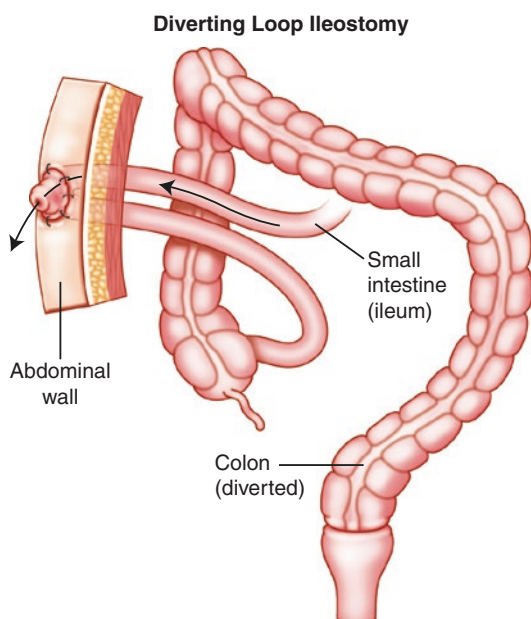
Diverting Loop Ileostomy

Small
intestine
(ileum)

Abdominal
wall

Colon
(diverted)

Fig. 9.1 Diverting loop ileostomy

- Meta-analysis of randomized controlled trials comparing diverting loop colostomies to loop ileostomies shows no difference between the two groups in complications related to the stoma or in time to ostomy closure.

High-Risk Anastomoses

- There are certain clinical situations in which clinical judgment precludes the creation of an anastomosis, even with proximal diversion. Some factors to consider include severe malnutrition, significant immunosuppression, gross or longstanding fecal contamination, and the risk of developing hemodynamic instability in the postoperative period.

Abdominal Anastomoses

Small Bowel Anastomoses

- Both stapled and handsewn techniques can be used to complete small bowel anastomosis.
- In creating a stapled side-to-side anastomosis, the bowel is divided proximally and distally with a linear stapler with the staple line oriented along the axis from the mesentery to the antimesenteric border of the bowel and beveled from the mesenteric side away from the specimen. The antimesenteric corners of the transverse staple line are removed, and the limbs of the GIA stapler are introduced. As the stapler is closed, the mesentery of each limb of bowel should be pulled laterally to ensure that it is not included in the staple line. The common enterotomy is closed with a stapler or handsewn.
- A meta-analysis by Leung et al. failed to show any differences between surgical techniques for ileostomy reversal; however, there was a trend toward less postoperative bowel obstruction with stapled small bowel anastomoses.

Ileocolic Anastomoses

- Ileocolic anastomoses are frequently created after an ileocolic resection for Crohn's disease or a right hemicolectomy for cancer.
- A recent Cochrane review compared the techniques of stapled side-to-side anastomoses with handsewn anastomoses. The overall leak rate was significantly lower for stapled anastomoses (2.5%) compared with handsewn anastomoses (6%).
  - When creating a stapled side-to-side (functional end-to-end) anastomosis, up to four linear stapler firings may be needed to construct the anastomosis. Cost can be contained and overlapping staple lines avoided by creating a "Barcelona" anastomosis (Fig. 9.2a–d). In this technique, after the mesentery of the bowel has been divided up to the points of proximal and distal resection, two enterotomies are created on the antimesenteric border of the bowel. The limbs of a GIA stapler are advanced into these openings and fired along the antimesenteric border of the bowel. The common enterotomy is then closed and the specimen transected with a second firing of a linear stapler.
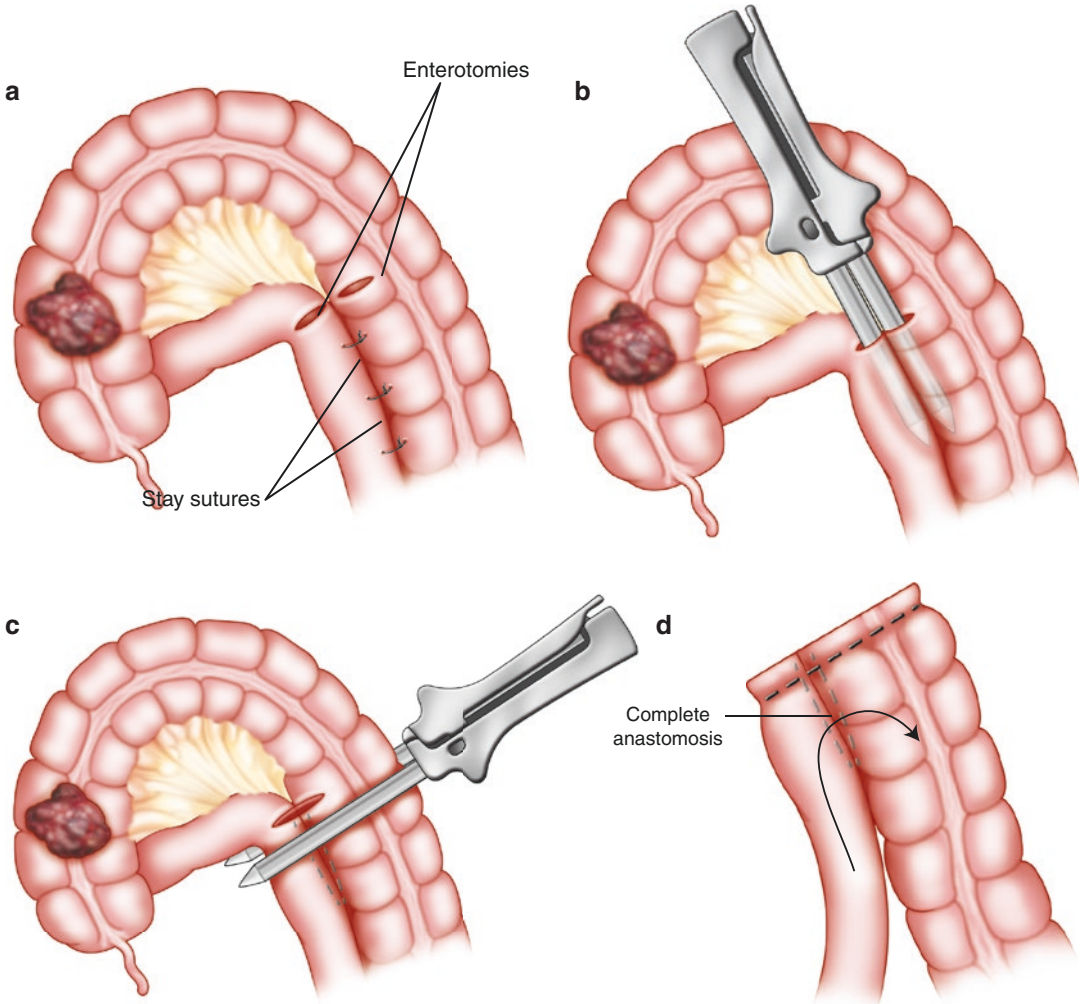- Another technique for an ileocolic anastomosis is the stapled end-to-side technique in

Fig. 9.2 (**a**–**d**) Barcelona anastomosis. (**a**) Stay sutures are placed and two antimesenteric enterotomies are made. (**b**) A linear stapler is used to construct the common wall. (**c**) An additional firing of the linear stapler is used to complete the anastomosis and resect the specimen. (**d**) Completed anastomosis

which an EEA stapler (25–29 mm) is used (Fig. 9.3a–d). The terminal ileum is divided, a purse-string suture is placed, and the EEA anvil is secured in the end of the ileum. A colotomy is created within the specimen, and the EEA stapler is advanced through the colotomy in an antegrade fashion to the antimesenteric border of the colon several centimeters distal to the intended margin of transection. The spike is brought out through the antimesenteric wall of the colon, and the anvil within the ileum is connected. The stapler is then closed and fired. The colon is divided with a

linear stapler a few centimeters proximal to the EEA anastomosis to ensure that the anastomosis and blind end of the colon is well perfused.

- For laparoscopic ileocolic resections and right hemicolectomies the anastomosis is typically created extracorporeally through a small periumbilical incision. In recent years, totally laparoscopic right hemicolectomy with intracorporeal anastomosis has gained popularity. The most common technique for performing an intracorporeal anastomosis is to create a stapled side-to-side (functional end-to-end)
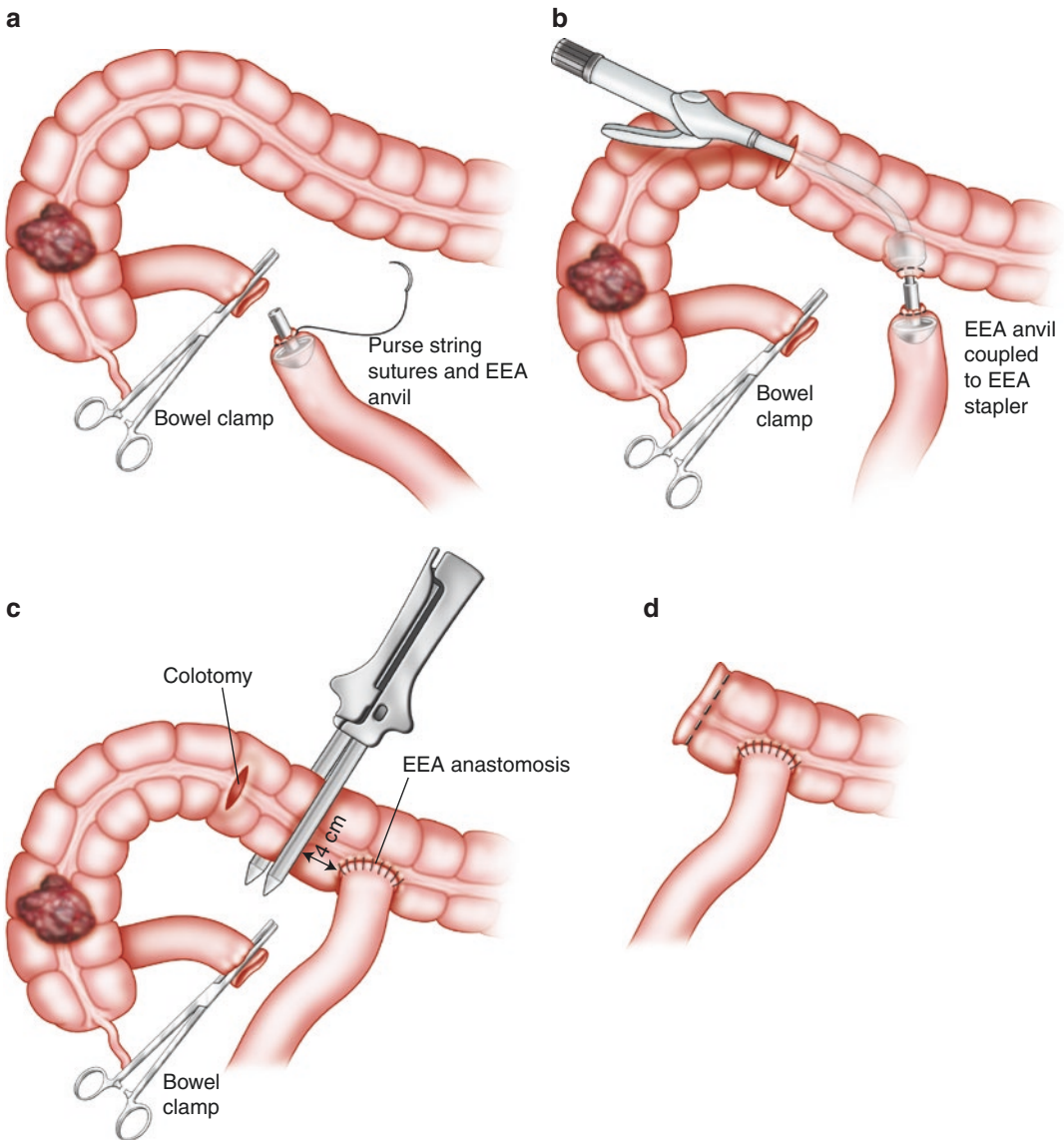
Fig. 9.3 (**a**–**d**) End-to-side ileocolic anastomosis. (**a**) An EEA anvil is placed into the end of small bowel through a purse string after dividing the bowel. (**b**) A colostomy is made and the EEA stapler is passed and coupled the spike to the EEA anvil. (**c**) Following the EEA anastomosis, a linear stapler is used to close the colon defect. (**d**) Completed anastomosis

anastomosis using laparoscopic linear staplers. The resultant common enterotomy can then be stapled or sewn closed.

• A meta-analysis of non-randomized comparative studies looking at intracorporeal anastomosis vs extracorporeal anastomosis for laparoscopic right hemicolectomies shows no difference in the rate of anastomotic leak.

Pelvic Anastomoses

Basic Principles of Pelvic Anastomoses

• Studies have documented that low pelvic anastomoses have a higher rate of leakage than more proximal anastomoses (Fig. 9.4).

- Tension is a concern with all anastomoses, but significantly more so in the pelvis, where anatomic factors can make it a significant challenge to create a tension-free anastomosis.

Fig. 9.4 Intestinal bypass

- Adequate visualization during dissection and creation of the anastomosis is extremely important and includes optimal lighting.
- When creating a pelvic anastomosis, extraneous structures can be incorporated in the anastomosis. One must be diligent in ensuring that the vagina is out of harm's way during the dissection, rectal division, and anastomotic construction.
- There are several reasons the descending colon should be used preferentially to the sigmoid colon when creating the colorectal anastomosis. (1) In a resection for cancer, the inferior mesenteric artery should be divided at its origin for an adequate lymphadenectomy, possibly resulting in insufficient blood supply to the sigmoid colon. (2) The sigmoid colon's thick muscular wall and diverticulosis makes this segment a poor substrate to use in creating what is already a precarious anastomosis.
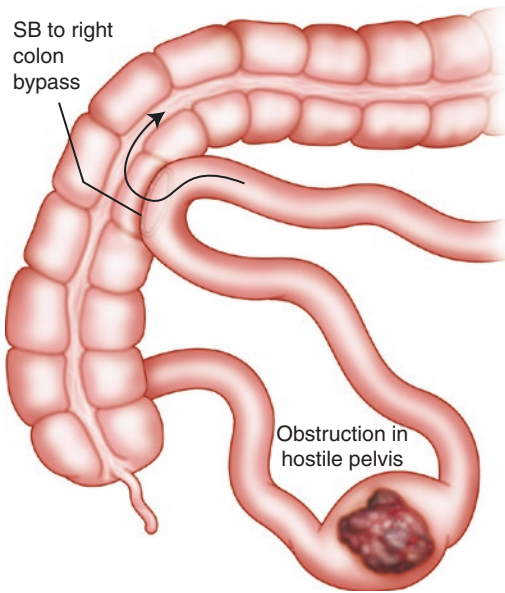
Stapled Colorectal Anastomoses

- With wide availability of circular EEA staplers, the stapled colorectal anastomosis has gained favor among surgeons (Fig. 9.5). Both
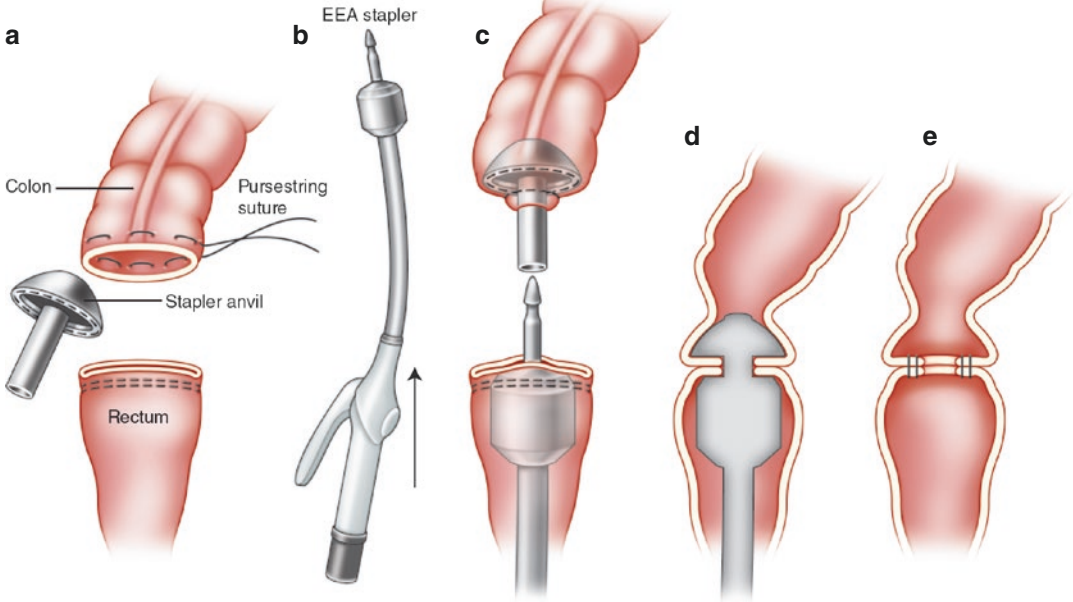

Fig. 9.5 Stapled colorectal anastomosis. Following a low anterior resection, the EEA stapler is used to construct an end-to-end anastomosis

single-stapled and double-stapled techniques will be described.

- The stapler anvil is secured in the proximal colon with a purse string. The pre-anastomotic colon falls easily into the pelvis, aligned in a straight course to the left of the ligament of Treitz. Evaluate the colon blood flow. The EEA stapler is introduced through the anal canal and remaining rectum to the transverse rectal staple line.
- The stapler spike is advanced slowly under close scrutiny of the abdominal operator and should be delivered near the midpoint of the transverse staple line. The anvil is secured to the spike, and the stapler is closed under direct visualization – inspection for alignment is repeated. The stapler is fired and then opened and removed per manufacturer's instructions.
- The single-stapled technique differs from the double-stapled technique in that there is no transverse staple line on the rectal pouch.

Instead, the rectum is divided sharply, and a purse string is also placed around the open rectal stump prior to placing the stapler in the rectum.

- Rarely, advancing the EEA stapler to the apex of the rectal stump can prove to be extremely difficult. Circumferential mobilization of the rectum in the mesorectal fascial plane will often eliminate the kinks or folds that inhibit stapler introduction. If this fails, the anastomosis can be created in an end-to-side fashion on the anterior wall of the rectum, several centimeters below the transverse staple line.

Handsewn Colorectal Anastomosis

- In the upper and mid-rectum, it is possible to create a handsewn colorectal anastomosis (Fig. 9.6a–d). The evidence suggests that
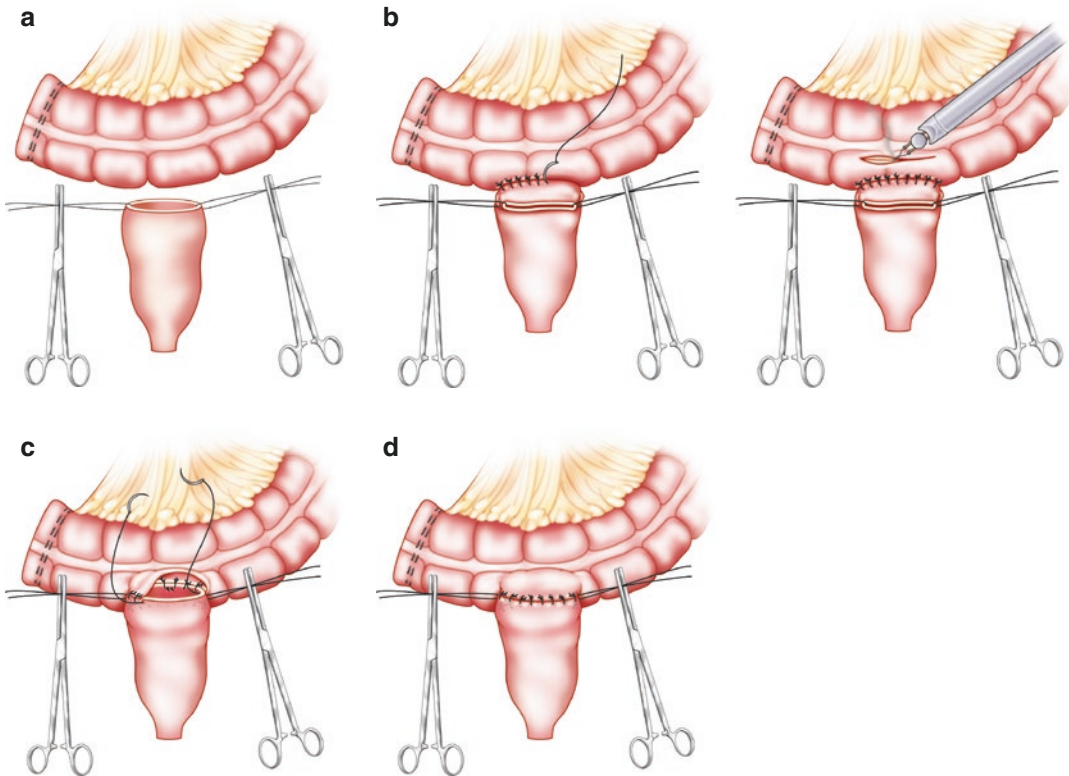

Fig. 9.6 (**a**–**d**) Handsewn colorectal anastomosis. (**a**) The distal end of the colon is closed, and stay sutures are placed on the rectum. (**b**) A posterior layer of sutures are placed (left) and a colotomy is made (right) to match the size of the opening on the rectal stump. (**c**) The anastomosis is constructed using two continuous running sutures. (**d**) The anterior suture line is oversewed with interrupted sutures

handsewn and stapled colorectal anastomoses are equivalent in leak rate.

- If a handsewn anastomosis is selected, there is no proven advantage of double-layer over single-layer anastomosis. We will describe a two-layer colorectal anastomosis, but the techniques to create a single-layer anastomosis are similar.
- The fatty mesentery of the colon and rectum makes a handsewn end-to-end anastomosis difficult to perform. Baker described a side-to-end colon to rectal anastomosis that is created several centimeters proximal to this closed end of the colon. A posterior layer of interrupted Lembert sutures is placed, and then a longitudinal antimesenteric colotomy is created. A running layer absorbable monofilament suture is started at the midpoint of the posterior wall and advanced posterior inner layer. As the sutures proceed onto the anterior aspect of the anastomosis, a Connell suture is used to create the anterior inner layer closure. The anterior suture line is then oversewn with interrupted Lembert sutures.

Ileorectal Anastomosis

- The ileorectal anastomosis after an abdominal colectomy is performed in the same fashion and following the same precautions as the colorectal anastomosis. Often, the small caliber of the ileum will not accommodate the use of the larger EEA stapler, and a smaller 25 mm stapler diameter is required.

Ultralow Colorectal and Coloanal Anastomoses

- The techniques involved in creating the low anastomoses in the pelvis remain the same as the upper rectal anastomoses. However, in addition to the technical challenges inherent in creating a low anastomosis, the surgeon must be mindful of the functional consequences of resecting the majority of the rectal reservoir.

Neorectal Reservoirs

- Using techniques developed for restorative proctocolectomy, Lazorthes and Parc both proposed the creation of a colonic reservoir in order to decrease the functional consequences of a low anastomosis.
- Over the ensuing years, multiple studies demonstrate that the colonic J-pouch is superior to the straight coloanal anastomosis in terms of frequency, incontinence, and quality of life and long-term results show that these functional advantages are durable out to 5 years.
- Several trials evaluating smaller (5–6 cm) colonic pouches found them to be superior to larger pouches.
- Creation of the colonic J-pouch first requires confirmation that the colon is adequately mobilized and that the intended apex of the pouch will reach the cuff without tension (Fig. 9.7a–d). An antimesenteric colotomy is then created 5–6 cm from the divided end of the colon. A linear cutting stapler is inserted through this colotomy, with one limb of the stapler inserted into the blind end and the other limb delivered up the proximal limb (avoid including the mesentery in the staple line) of the colon the pouch is created by firing the stapler. If a stapled anastomosis is to be created, a purse-string suture is then placed around the apical colotomy, and the anvil is secured in the pouch. The anastomosis is then created similarly to other colorectal anastomoses.
- Some studies showed a significant decrease in the anastomotic leak rate for the colonic J-pouch when compared to a straight coloanal anastomosis.
- Reservoirs anastomosed more than 5–6 cm above the anal verge may actually create problems emptying.
- Patients with a small pelvis, fatty mesentery, extensive diverticulosis, mucosectomy, or insufficient colonic length are not good candidates for J-pouch creation.
- Z'graggen was the first to describe the transverse coloplasty as an alternative to the colonic J-pouch.
- An 8 cm longitudinal incision is made on the antimesenteric colon with the distal end of the
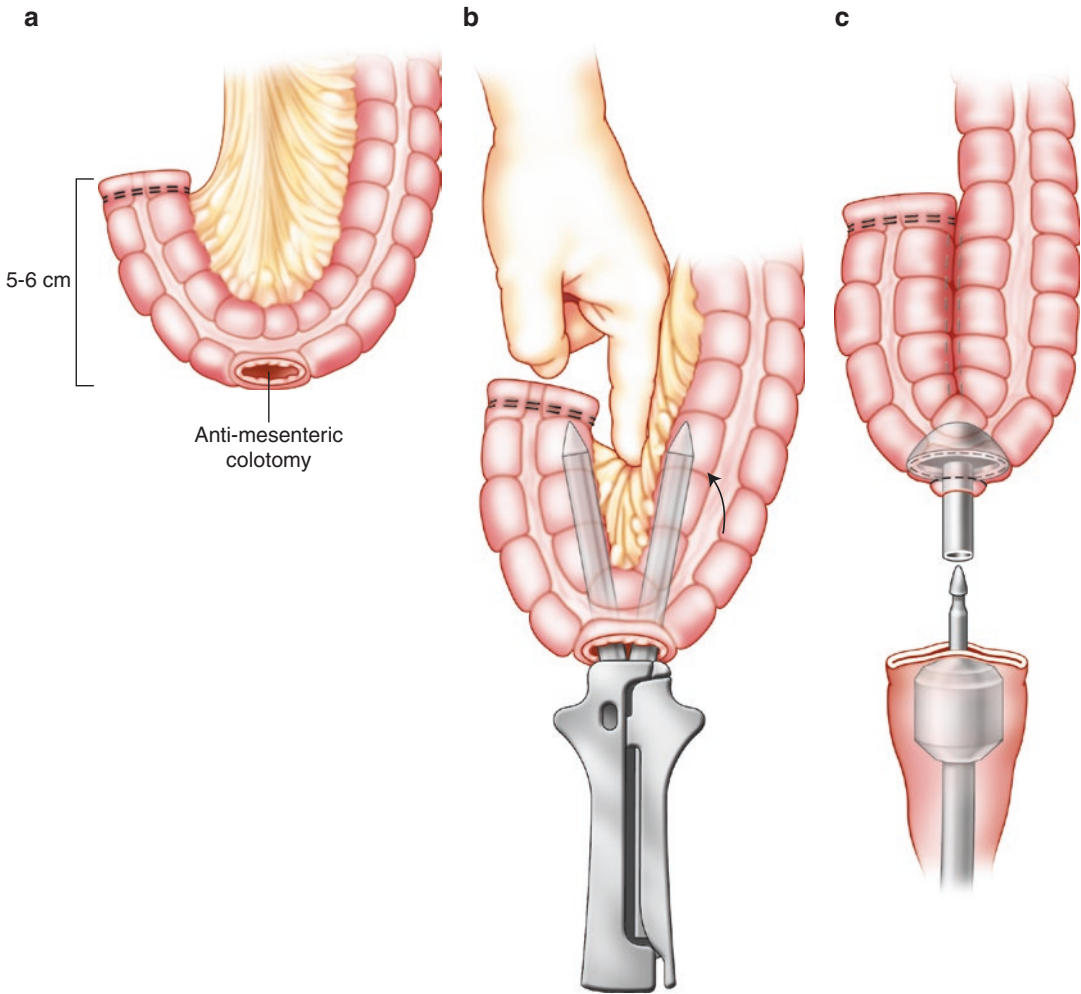
Fig. 9.7 (**a**–**c**) Colonic J-pouch. (**a**) A 5–6 cm colonic J-pouch is formed, and a colotomy is made on the antimesenteric portion of the bowel wall. (**b**) The pouch is formed using a linear stapler with 1–2 loads ensuring the colon mesentery is pulled out of the staple line. (**c**) The colorectal anastomosis is constructed using an EEA stapler

incision approximately 4 cm proximal to the stapler anvil, and the colotomy is closed transversely (Fig. 9.8a–d).

- A large, multicenter randomized controlled trial compared the colonic J-pouch to the transverse coloplasty (and comparing coloplasty to straight coloanal anastomosis for patients in whom a J-pouch was not technically possible). At 2 years, the colonic J-pouch proved superior to the transverse coloplasty in frequency, clustering, soilage, and continence. Although the sample sizes were smaller, the transverse coloplasty showed no improvement in any functional assessment compared to the straight coloanal anastomosis.

- Huber et al. proposed the side-to-end anastomosis (Fig. 9.9a, b). A randomized controlled trial compared side-to-end anastomosis with colonic J-pouch and showed that the techniques had similar frequency, continence, and functional scores. At 2 years neorectal volumes were 40% higher in the colonic J-pouch group.

- A systematic review comparing the side-to-end anastomosis to the colonic J-pouch did not show any difference in function between these two techniques.

- The physiologic basis for the improved function of neorectal reservoirs is not completely understood, but the increased volume reservoir
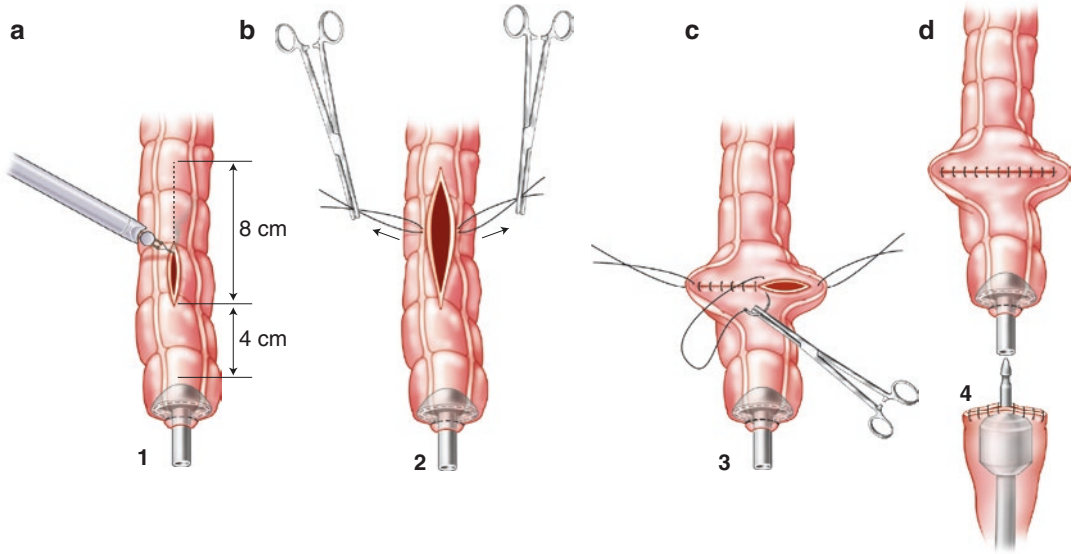
Fig. 9.8 (**a**–**d**) Transverse coloplasty. (**a**) An 8 cm linear colostomy is made 4 cm from the distal end of the colon (panel 1). (**b**) The anvil is placed in the end and stay sutures are placed at the midpoint on each side of the colotomy (panel 2). (**c**) The longitudinal colotomy is closed in a transverse fashion (panel 3). (**d**) An end-to-end anastomosis is performed (panel 4)

Fig. 9.9 (**a**–**b**) Side-to-end coloanal anastomosis. (**a**) A colotomy is made proximal to the open end of the colon (left), and the EEA anvil is passed through this opening (right). (**b**) The colonic opening is closed using a linear stapler (left), and the anastomosis is performed using an EEA stapler (right)
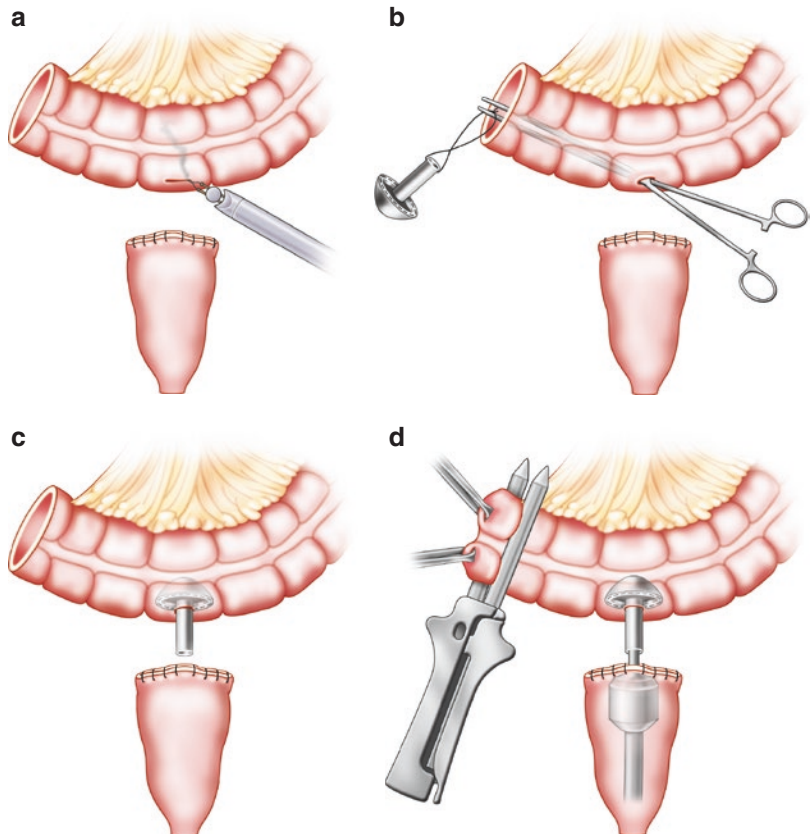
is one explanation. Ho et al. showed the function of the J-pouch was superior (J-pouch vs straight) but the neorectal capacity was similar for both groups. Furst et al. reached the same conclusion and suggested that the pouch works by decreasing forward propulsive motility in the J segment.

- Ho et al., using radioactive isotopes, found that solid stool transport through the colon was the same for both techniques and that the J-pouch had significantly better retention of liquid stools in the distal colon above the pouch.

- In summary, for low colorectal or coloanal anastomoses, the colonic J-pouch may give the best functional results, but the long-term durability of this benefit is unclear. When the J-pouch is not feasible, the transverse coloplasty or the straight coloanal anastomosis appear to offer similar functional results. The role of the side-to-end coloanal anastomosis is still undefined.

Handsewn Coloanal Anastomosis

- There are circumstances in which a handsewn coloanal anastomosis is the only option to avoid an ostomy.

- In order to perform a handsewn anastomosis, the surgeon must have good visualization of the cut edge of the anal canal. This is accomplished through a combination of sutures or self-retaining retractors (for exposure) and lighting.

- The transanal dissection, either intersphincteric dissection or mucosectomy, should be performed as appropriate for the pathology.

- The orientation of the colon mesentery should be confirmed after it is passed through the anal canal. A simple full-thickness suture is then placed in each quadrant of the anal canal. The anastomosis is then completed by placing intervening sutures in the remaining gaps.

- Baik et al. reported on a case series of patients that had straight handsewn coloanal anastomoses, 31% of patients had anal incontinence at 6 months. The percentage of patients with incontinence decreased to 14% at 1 year.

Twenty percent of patients reported more than 6 bowel movements a day at 1 year.

- In the only randomized controlled trial comparing handsewn to stapled coloanal J-pouch anastomoses (total 37 pts), Laurent et al. reported that functionally the two groups appeared equivalent.

Assessment of Pelvic Anastomosis

- Some form of intraoperative anastomotic assessment should be performed at the time of creation. Mechanical tests of anastomoses demonstrate intraoperative leaks in 5–25% of anastomoses.

- The air insufflation test is the simplest to perform, and multiple studies show it reduces postoperative anastomotic leak rates. In addition to allowing for an air-leak test, intraoperative flexible endoscopic assessment of the anastomosis allows for visualization of the anastomosis.

- There is no definitive confirmation that intraoperative endoscopy is more effective than a simple air-leak test.

- The bowel several centimeters proximal to the anastomosis should be occluded manually or with a bowel clamp. Saline is added to the pelvis to cover the anastomosis, and air is insufflated into the rectum. The anastomosis should be manipulated in all directions to confirm that a small leak is not being hidden or occluded by extraneous tissue. If there is bubbling, the saline should be slowly removed with suction down to the level of the anastomosis in order to localize the leak.

- When an intraoperative leak is discovered, options include suture repair, proximal diversion, or takedown and refashioning of the anastomosis. For small leaks, suture repair is often adequate.

- Larger leaks, circumferential leaks, and leaks that cannot be visualized or adequately repaired require takedown and refashioning of the anastomosis.

Troubleshooting Problems with Pelvic Anastomoses

Unanticipated Pelvic Anastomosis

- Situations arise in which the surgeon must create an unplanned pelvic anastomosis and the patient is positioned so that access to the perineum is not possible. One option is repositioning that allows for the standard double-stapled anastomosis.
- It is not always necessary or possible to reposition the patient. A handsewn anastomosis remains an option, but becomes more difficult lower in the pelvis.

- It is also possible to create a stapled side-to-end anastomosis similar to the Baker anastomosis with the patient in supine or even lateral position. In this technique the anvil for the circular stapler is secured in the rectum and the stapler introduced into the colon via a colotomy. (Fig. 9.10a–d)

Inadequate Colonic Length

- For a left colectomy, adequate reach is usually achieved by performing basic maneuvers including splenic flexure mobilization, division of the inferior mesenteric artery at its origin,

Fig. 9.10 (**a–d**) Unexpected colorectal anastomosis. (**a**) A purse string is sewn into the open end of the rectum. (**b**) The EEA anvil is placed through the rectal stump, and the EEA stapler is passed retrograde through the open end of the colon. (**c**) The anastomosis is completed with firing of the EEA stapler. (**d**) A liner stapler is used to close the open end of the colon
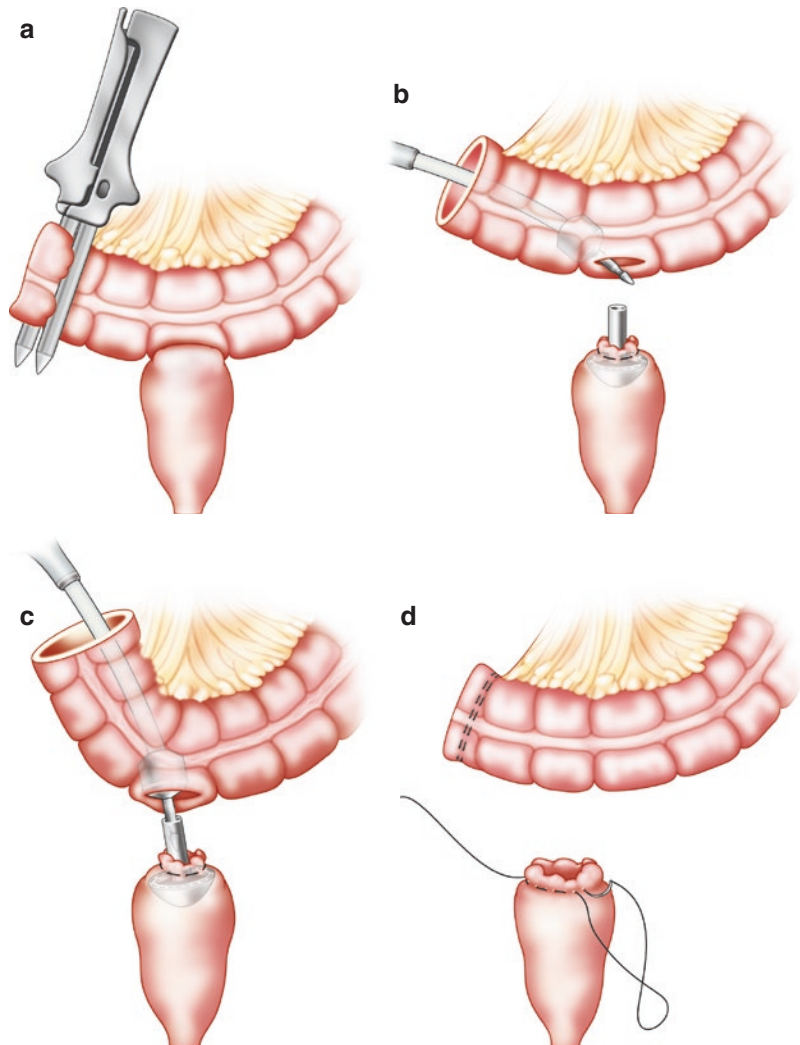
and division of the inferior mesenteric vein at the inferior border of the pancreas cephalad to the vein branch to the splenic flexure.

- Complete mobilization is accomplished by division of the peritoneal attachments in the left upper quadrant, separation of the omento-colic attachments to the distal transverse colon, deliberate division of the renocolic attachments of the mesentery to Gerota's fascia of the left kidney, and lysis of the gastro-colic attachments between the posterior gastric wall and the transverse colon mesentery.
- Resection of the splenic flexure as part of an extended left hemicolectomy often presents a challenge in obtaining adequate colonic length.
- Serial ligation of the middle colic vessels proceeding from left to right provides more length. Unfortunately, adequate blood supply and adequate reach sometimes find themselves at odds.

- If, after division of the middle colic pedicles, there is compromise of the blood flow to the pre-anastomotic colon, it should be resected back to the point where there is good arterial inflow and satisfactory venous drainage.
- If the colon will not reach the pelvis in the typical course to the left of the ligament of Treitz, one opion is to create a window in the terminal ileal mesentery that allows passage of the colon through this retroileal opening (Fig. 9.11a, b). The window is created in the space between the ileocolic artery and the distal superior mesenteric artery.
- Another option is mobilization of the hepatic flexure and counter-clockwise rotation of the colon (Deloyers' procedure) (Fig. 9.12a–d).
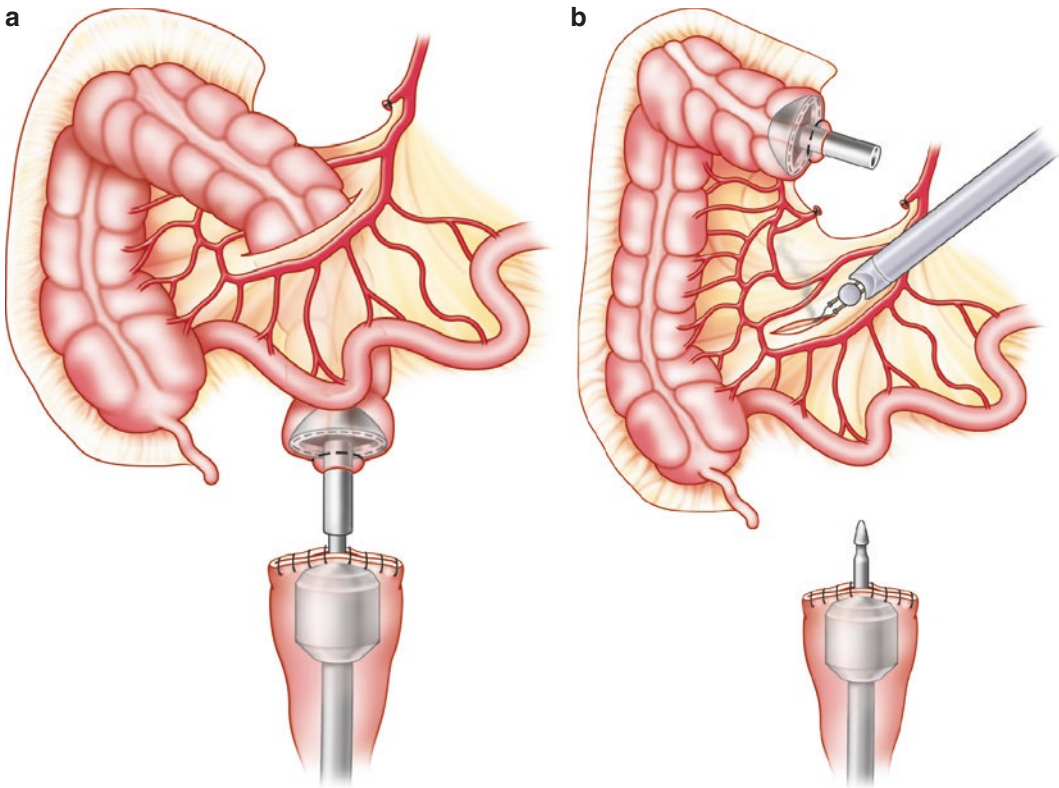
Fig. 9.11 (**a** and **b**) Retroileal pull-through. (**a**) A window is made on the superior aspect of the ileocolic pedicle after the terminal ileum is mobilized from the retroperito-neum. (**b**) The colon is passed through this window and into the pelvis to perform the end-to-end anastomosis
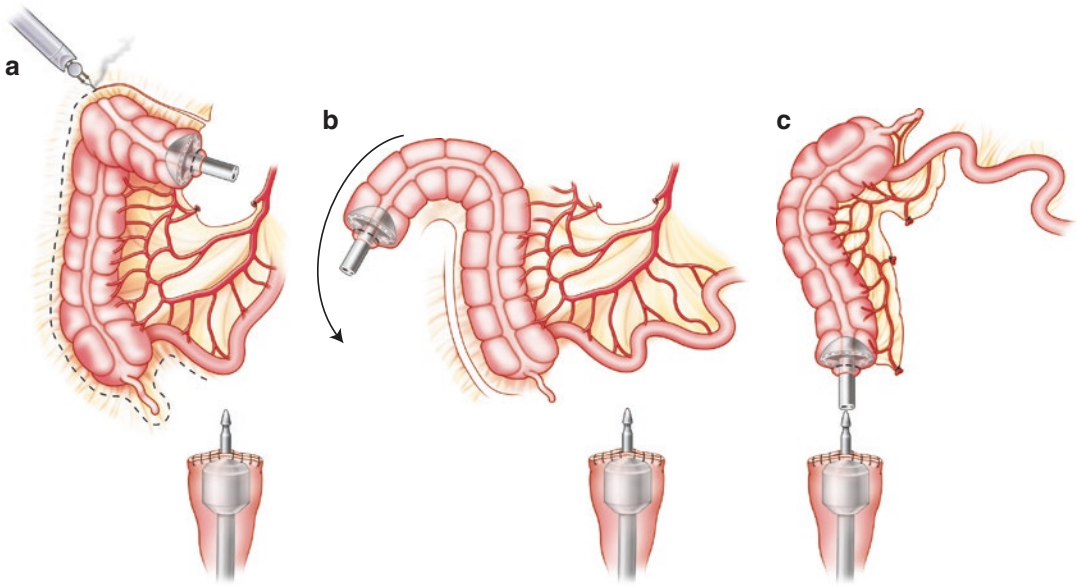
Fig. 9.12 (**a**–**c**) Deloyer's technique. (**a**) The hepatic flexure and right colon are mobilized laterally along with the terminal ileum from the retroperitoneum. (**b**) The colon is rotated in a counter-clockwise direction and delivered to the pelvis. (**c**) The anastomosis is constructed

- If all salvage maneuvers fail to allow a tension-free colorectal anastomosis with adequate blood supply, remaining options include a completion colectomy with an ileorectal anastomosis or an end colostomy.

Intraoperative Anastomotic Failure

- Failed anastomoses are inevitable in pelvic surgery.
- When a pelvic anastomosis fails, an attempt should be made to resect below the anastomosis and recreate it in standard fashion.
- If it is impossible to place the transverse stapler below a failed anastomosis, the anastomosis should be excised and a purse string placed around the open rectum. The circular stapler is then passed through the anal canal and delivered to the point just below the open end of the rectum and purse string. The stapler spike is advanced through the open rectal cuff, and the purse string is tied around the spike and inspected to confirm that the purse string is complete. A standard stapled anastomosis to the pre-anastomotic colon is then performed and assessed.